REMARKS

Independent claims 1 and 21 have been amended to recite the subject matter of claims 18 and 30, respectively. Claims 10-12 and 26 have been amended to improve the clarity of the claims. Claims 19, 20, 31, and 32 have been amended to improve antecedent basis. No new matter has been added.

The Office Action mailed July 13, 2005, has been received and reviewed. Claims 1-32 are currently pending in the application. Claims 1-32 stand rejected. Applicant has amended claims 1, 10-12, 19-21, 26, 31, and 32, canceled claims 18 and 30, and respectfully requests reconsideration of the application as amended herein.

Information Disclosure Statement

The Examiner indicates that the literature documents listed on the Information Disclosure Statement filed February 27, 2004, have not been considered. Applicant notes that a Supplemental Information Disclosure Statement that included copies of these literature documents was filed on September 28, 2005. Applicant respectfully requests that the information cited on the Supplemental Information Disclosure Statement be made of record herein, and that a copy of the Supplemental Information Disclosure Statement, as initialed by the Examiner, be returned to Applicant's counsel with the next Office Action.

35 U.S.C. § 102(b) Anticipation Rejections

Anticipation Rejection Based on U.S. Patent No. 5,904,565 to Nguyen *et al.*

Claims 1 and 6-8 stand rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,904,565 to Nguyen *et al.* ("Nguyen"). Applicant respectfully traverses this rejection, as hereinafter set forth.

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Verdegaal Brothers v. Union Oil Co. of California*, 2 U.S.P.Q.2d 1051, 1053 (Fed. Cir. 1987). The identical invention must be shown in as complete detail as is contained in the claim. *Richardson v. Suzuki Motor Co.*, 9 U.S.P.Q.2d 1913, 1920 (Fed. Cir. 1989).

Nguyen discloses a method of forming a copper interconnection structure between levels in an integrated circuit. Nguyen at column 1, lines 7-12. Barrier layers are selectively formed in the integrated circuit to prevent copper contamination and are selectively etched to improve conductivity between copper levels in a via or damascene structure. *Id.* at column 3, lines 51-60. The integrated circuit includes a metal level and a dielectric interlevel. *Id.* at column 6, lines 1-3. A nonconductive barrier layer is formed over the dielectric interlevel. *Id.* at column 6, lines 5-7. An additional barrier layer is formed over sidewall surfaces of the dielectric interlevel, areas of the metal level, and a surface of the nonconductive barrier layer. *Id.* at column 6, lines 11-16. The additional barrier layer is selectively etched, by anisotropically etching, to remove the additional barrier layer over areas of the metal level and the surface of the nonconductive barrier layer. *Id.* at column 4, lines 10-14 and column 6, lines 17-21. The additional barrier layer on the sidewall surfaces of the dielectric interlevel remains. *Id.* at column 6, lines 21-23. The additional barrier layer is formed from conductive and nonconductive materials. *Id.* at column 6, lines 11-16.

Independent claim 1 recites a method of forming a barrier layer on a surface of a semiconductor device structure. The method comprises providing a semiconductor substrate and forming a dielectric layer over the semiconductor substrate. The dielectric layer has at least one trench. A metallization layer is selectively deposited in the at least one trench and a barrier layer is formed overlying the metallization layer and the dielectric layer. The barrier layer comprises at least one conductive portion over the metallization layer and at least one nonconductive portion over the dielectric layer.

Nguyen does not anticipate claim 1 because Nguyen does not expressly or inherently describe each and every element of the claim. Specifically, Nguyen does not expressly or inherently describe the element of "forming a barrier layer overlying the metallization layer and the dielectric layer, the barrier layer comprising at least one conductive portion over the metallization layer and at least one nonconductive portion over the dielectric layer." While Nguyen discloses forming a barrier layer, Nguyen does not disclose that this barrier layer includes a conductive portion formed over a metallization layer and a nonconductive portion formed over a dielectric layer.

Since Nguyen does not expressly or inherently describe each and every element of claim 1, the anticipation rejection is improper and should be withdrawn

Claims 6-8 are allowable, *inter alia*, as depending from an allowable base claim.

Claim 8 is further allowable because Nguyen does not expressly or inherently describe that a metal layer selected from the group consisting of titanium, zirconium, and hafnium is deposited over the metallization layer and the dielectric layer.

35 U.S.C. § 103(a) Obviousness Rejections

Obviousness Rejection Based on Nguyen

Claims 2-5 and 9-32 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Nguyen. Claims 18 and 30 have been canceled, rendering moot the rejection as to these claims. Applicant respectfully traverses this rejection as to the remaining claims, as hereinafter set forth.

M.P.E.P. 706.02(j) sets forth the standard for an obviousness rejection:

> To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

The obviousness rejection of claims 2-5 and 9-17, 19-29, 31, and 32 is improper because the cited reference does not teach or suggest all of the claim limitations and does not provide a motivation to produce the claimed invention.

Claims 2-5, 9-17, 19, and 20 are allowable, *inter alia*, as depending from an allowable base claim, namely claim 1. Claim 1 is allowable for substantially the same reasons as discussed above in the anticipation rejection. Specifically, Nguyen does not teach or suggest the limitation of "forming a barrier layer overlying the metallization layer and the dielectric layer, the barrier layer comprising at least one conductive portion over the metallization layer and at least one

nonconductive portion over the dielectric layer."

Claim 3 is further allowable because Nguyen does not provide any teaching or suggestion to form the dielectric layer from a polymer selected from the group consisting of a foamed polymer, a fluorinated polymer, and a fluorinated-foamed polymer.

Claim 4 is further allowable because Nguyen does not provide any teaching or suggestion to form the dielectric layer from polyimide.

Claim 10 is further allowable because Nguyen does not provide any teaching or suggestion to deposit the metal layer by selecting an implant energy so that the metal layer penetrates a surface of the metallization layer and the dielectric layer. Nothing in Nguyen teaches or suggests that a metal layer, which is to be formed into a barrier layer, penetrates a surface of the metallization layer and the dielectric layer.

Claim 11 is further allowable because Nguyen does not provide any teaching or suggestion to deposit the metal layer by selecting the implant energy to be from about 0.1 keV to about 2.0 keV so that the metal layer penetrates the surface of the metallization layer and the dielectric layer.

Claim 12 is further allowable because Nguyen does not provide any teaching or suggestion to select the implant energy so that the metal layer penetrates a depth of from about 5Å to about 50Å into the metallization layer and the dielectric layer.

Claim 13 is further allowable because Nguyen does not provide any teaching or suggestion to form the barrier layer by reacting at least a portion of the metal layer with nitrogen. Rather, the barrier layer of Nguyen is formed by a conformal deposition technique.

Claim 14 is further allowable because Nguyen does not provide any teaching or suggestion to form the barrier layer by exposing the metal layer to a nitrogen atmosphere.

Claim 15 is further allowable because Nguyen does not provide any teaching or suggestion to expose the metal layer to the nitrogen atmosphere for an amount of time sufficient to incorporate nitrogen into at least a portion of the metal layer.

Claim 16 is further allowable because Nguyen does not provide any teaching or suggestion to expose the metal layer to nitrogen, nitric oxide, nitrous oxide, or ammonia.

Claim 17 is further allowable because Nguyen does not provide any teaching or

suggestion to expose the metal layer to a nitrogen plasma or a rapid thermal nitrogen treatment.

Claim 19 is further allowable because Nguyen does not provide any teaching or suggestion to form the conductive portion over the metallization layer by reacting nitrogen with a first portion of the barrier layer to form at least one metal nitride portion.

Claim 20 is further allowable because Nguyen does not provide any teaching or suggestion to form the nonconductive portion over the dielectric layer by reacting a second portion of the barrier layer with the dielectric layer to form at least one metal oxide portion, metal oxynitride portion, metal carbide portion, or metal carbonitride portion.

Nguyen also does not provide a motivation to produce the claimed invention. To provide a motivation or suggestion to combine, the prior art or the knowledge of a person of ordinary skill in the art must "suggest the desirability of the combination" or provide "an objective reason to combine the teachings of the references." M.P.E.P. § 2143.01. The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. *Id.* (emphasis in original). "[I]t is fundamental that rejections under 35 U.S.C. § 103 must be based on evidence." *In re Lee*, 277 F.3d 1338, 1342 (Fed.Cir. 2002). This evidence "must be based on objective evidence of record" and can not be based on conclusory statements. *Id.* at 1343 and 1345.

The Examiner argues that the limitations recited in dependent claims 2-5, 9-17, 19, and 20 would be obvious to one of ordinary skill in the art because "Nguyen shows the method substantially as claimed" but "lacks anticipation only in not teaching the materials of the dielectric, methods and details of deposition of the metal layer by implantation; formation parameters associated with deposition of the barrier including nitrogen exposure." Office Action of July 13, 2005, p. 4. The Examiner states that "[i]t would have been obvious to one of ordinary skill in the art to have taught the materials of the dielectric, methods and details of deposition of the metal layer by implantation; and, formation parameters associated with deposition of the barrier including nitrogen exposure, in the method of Nguyen, with the motivation that these associated parameters and deposition methods are conventional alternatives and produce equivalent quality devices." *Id.*

However, this reasoning by the Examiner is conclusory and is not based on objective

evidence of record. Nothing in Nguyen or in the knowledge generally available to one of ordinary skill in the art suggests the desirability of producing the claimed invention or provides an objective reason to produce the claimed invention. While Nguyen teaches forming a barrier layer, this barrier layer does not include at least one conductive portion over a metallization layer and at least one nonconductive portion over a dielectric layer. As such, Nguyen does not provide any teaching or suggestion for forming a barrier layer that has at least one conductive portion over a metallization layer and at least one nonconductive portion over a dielectric layer.

Furthermore, nothing in Nguyen or in the knowledge generally available to one of ordinary skill in the art suggests the desirability of, or provides an objective reason for, forming a barrier layer by reacting a portion of a metal layer with nitrogen, such as by exposing a metal layer to a nitrogen atmosphere, as recited in the dependent claims. In fact, Nguyen teaches very few details on how its barrier layer is formed and only states that the barrier layer is deposited conformally. As such, the barrier layer of Nguyen appears to be deposited as a complete or finished layer. Therefore, this barrier layer is not formed by reacting a metal layer in a nitrogen atmosphere, as recited in dependent claims 7-17, 19, or 20.

Independent claim 21 recites a method of forming a barrier layer on a surface of a semiconductor device structure. The method comprises providing a semiconductor substrate and forming a dielectric layer over the semiconductor substrate, the dielectric layer having at least one trench. A metallization layer is selectively deposited in the at least one trench and a metal layer is deposited overlying the metallization layer and the dielectric layer. The metal layer is exposed to a nitrogen atmosphere to form a barrier layer overlying the metallization layer and the dielectric layer. The barrier layer comprises at least one conductive portion over the metallization layer and at least one nonconductive portion over the dielectric layer.

Nguyen does not teach or suggest all of the limitations of claim 21 because Nguyen does not teach or suggest the limitation of "exposing the metal layer to a nitrogen atmosphere to form a barrier layer overlying the metallization layer and the dielectric layer, the barrier layer comprising at least one conductive portion over the metallization layer and at least one nonconductive portion over the dielectric layer." Nothing in Nguyen teaches or suggests that its barrier layer is formed by exposing a metal layer to a nitrogen atmosphere. Rather, as previously

discussed, Nguyen teaches very few details on how its barrier layer is formed, beyond that it is conformally deposited. The barrier layer of Nguyen appears to be formed as a complete layer and, therefore, is not formed by reacting a metal layer in a nitrogen atmosphere. In addition, the barrier layer of Nguyen does not have at least one conductive portion over the metallization layer and at least one nonconductive portion over the dielectric layer.

In addition, there is no motivation to produce the invention of claim 21 for substantially the same reasons as discussed above for dependent claims 2-5, 9-17, 19, and 20.

Since the cited reference does not teach or suggest all of the claim limitations and does not provide a motivation to produce the claimed invention, the obviousness rejection of claim 21 is improper and should be withdrawn.

Claims 22-32 are allowable, *inter alia*, as depending from an allowable base claim.

Claim 24 is further allowable for substantially the same reasons as claim 10.

Claim 25 is further allowable for substantially the same reasons as claim 11.

Claim 26 is further allowable for substantially the same reasons as claim 12.

Claim 27 is further allowable for substantially the same reasons as claim 15.

Claim 28 is further allowable for substantially the same reasons as claim 16.

Claim 29 is further allowable for substantially the same reasons as claim 17.

Claim 31 is further allowable for substantially the same reasons as claim 19.

Claim 32 is further allowable for substantially the same reasons as claim 20.

ENTRY OF AMENDMENTS

The amendments to claims 1, 10-12, 19-21, 26, 31, and 32 should be entered by the Examiner because the amendments are supported by the as-filed specification and drawings and do not add new matter to the application.

CONCLUSION

Claims 1-17, 19-29, 31, and 32 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain that might be resolved by a telephone conference, the Examiner is respectfully invited to contact Applicant's undersigned attorney.

Respectfully submitted,

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